

# NUCLEAR, PLASMA, AND RADIOLOGICAL ENGINEERING: POWER, SAFETY & ENVIRONMENT, BS

*for the degree of Bachelor of Science in Nuclear, Plasma, & Radiological Engineering with a concentration in Power, Safety & Environment*

Nuclear, plasma, and radiological engineering encompasses a broad and diverse but complimentary set of engineering disciplines with a wide variety of applications. The first two years of the NPRE curriculum provides a strong foundation in sciences (physics, mathematics, and chemistry), in engineering (mechanics and thermodynamics), in computer use, and in nuclear energy systems. Most of the technical core and concentration coursework takes place in the third and fourth years of the curriculum. Students choose from among three concentrations: power, safety and the environment; plasma and fusion science and engineering; and radiological, medical and instrumentation applications. Each concentration requires students acquire a depth of understanding of the area but with flexibility to develop advanced technical expertise depending upon the student's specific educational and professional interests. Students demonstrate proficiency in the engineering design process in a senior design capstone course.

The power, safety and the environment concentration focuses on continued safe and reliable nuclear energy production. This relies on multifaceted engineering disciplines for design and analysis of large complex systems. Areas of scholarship and research in which students are involved include but are not limited to: advanced reactor design and safety, reactor physics and thermal-hydraulics, nuclear materials, instrumentation and controls, training and education, fuel design and performance, waste management, reactor accident analysis, risk and reliability, probabilistic risk assessment, human factors, validation and verification, uncertainty analysis, energy and security, and nonproliferation. Cross-cutting areas of study and research include modeling and simulation and numerical analysis and computational methods. Students confer with their academic advisor on a chosen course set to ensure that a strong program is achieved. Technical electives are chosen from among NPRE courses and courses outside the department in the subfields of: thermal sciences; power and control systems; solid, fluid and continuum mechanics; computational sciences and engineering, and environmental engineering and science. The program prepares graduates for positions in industry, research laboratories, federal and regulatory agencies, as well for further graduate study.

## Current Program Educational Objectives

*for the degree of Bachelor of Science in Nuclear, Plasma, & Radiological Engineering with a concentration in Power, Safety & Environment*

## Graduation Requirements

Minimum hours required for graduation: 128 hours.

Minimum Overall GPA: 2.0

Minimum Technical GPA (<https://go.grainger.illinois.edu/TechnicalGPA/>): 2.0

TGPA is required for NPRE 200 and NPRE 247. See Technical GPA (<https://go.grainger.illinois.edu/TechnicalGPA/>) to clarify requirements.

## University Requirements

Minimum of 40 hours of upper-division coursework, generally at the 300- or 400-level. These hours can be drawn from all elements of the degree.

Students should consult their academic advisor for additional guidance in fulfilling this requirement.

The university and residency requirements can be found in the Student Code (<https://studentcode.illinois.edu/article3/part8/3-801/>) (§ 3-801) and in the Academic Catalog (<http://catalog.illinois.edu/general-information/degree-general-education-requirements/>).

## General Education Requirements

Follows the campus General Education (Gen Ed) requirements (<https://courses.illinois.edu/gened/DEFAULT/DEFAULT/>). Some Gen Ed requirements may be met by courses required and/or electives in the program.

Code	Title	Hours
	Composition I	4-6
	Advanced Composition	3
	Humanities & the Arts (6 hours)	6
	Natural Sciences & Technology (6 hours)	6
	fulfilled by CHEM 102, PHYS 211, PHYS 212	
	Social & Behavioral Sciences (6 hours)	6
	fulfilled by ECON 102 or ECON 103 and any other courses approved as Social & Behavioral Sciences	
	Cultural Studies: Non-Western Cultures (1 course)	3
	Cultural Studies: US Minority Cultures (1 course)	3
	Cultural Studies: Western/Comparative Cultures (1 course)	3
	Quantitative Reasoning (2 courses, at least one course must be Quantitative Reasoning I)	6-10
	fulfilled by MATH 220 or MATH 221; and MATH 231, MATH 241, MATH 285, PHYS 211, PHYS 212; and CS 101 or CS 124	
	Language Requirement (Completion of the third semester or equivalent of a language other than English is required)	0-15

## Orientation and Professional Development

Code	Title	Hours
ENG 100	Grainger Engineering Orientation Seminar (External transfer students take ENG 300.)	1
NPRE 100	Orientation to NPRE	1
<b>Total Hours</b>		<b>2</b>

## Introductory Economics Elective

Code	Title	Hours	Code	Title	Hours																																																																																																												
ECON 102	Microeconomic Principles	3	<b>Required Course</b>		<b>2</b>																																																																																																												
or ECON 103	Macroeconomic Principles		NPRE 432	Nuclear Engrg Materials Lab	2																																																																																																												
<b>Total Hours</b>		<b>3</b>	<b>Technical Electives</b>		<b>15</b>																																																																																																												
<b>Foundational Mathematics and Science</b>																																																																																																																	
Code	Title	Hours	<p>From Departmentally Approved List of Technical Electives - students are to take at least 6 hours from the NPRE Power Concentration Electives list. The remaining hours may be taken from any course on the Technical Electives list. The student is to confer with their academic adviser on a chosen course set to ensure that a strong program is achieved.</p> <p>NPRE Power Concentration Electives List</p> <table border="1"> <thead> <tr> <th>Code</th> <th>Title</th> <th>Hours</th> </tr> </thead> <tbody> <tr> <td>NPRE 412</td> <td>Nuclear Power Econ &amp; Fuel Mgmt</td> <td>3 or 4</td> </tr> <tr> <td>NPRE 413</td> <td>Nuclear Separations and Fuel Reprocessing</td> <td>2 or 3</td> </tr> <tr> <td>NPRE 430</td> <td>Advanced Materials in Nuclear Engineering</td> <td>3</td> </tr> <tr> <td>NPRE 442</td> <td>Radioactive Waste Management</td> <td>3</td> </tr> <tr> <td>NPRE 457</td> <td>Safety Anlys Nucl Reactor Syst</td> <td>3 or 4</td> </tr> <tr> <td>NPRE 461</td> <td>Probabilistic Risk Assessment</td> <td>3 or 4</td> </tr> <tr> <td>NPRE 480</td> <td>Energy and Security</td> <td>0 to 4</td> </tr> <tr> <td>NPRE 498</td> <td>Special Topics</td> <td>1 to 4</td> </tr> </tbody> </table> <p>Other Technical Electives</p> <p>Technical Electives from NPRE or from other departments in the subfields: Thermal Sciences; Power and Control Systems; Solid, Fluid and Continuum Mechanics; Computational Sciences and Engineering; Environmental Engineering and Science.</p> <table border="1"> <thead> <tr> <th>Code</th> <th>Title</th> <th>Hours</th> </tr> </thead> <tbody> <tr> <td>ES 470</td> <td>Fuel Cells &amp; Hydrogen Sources</td> <td>3</td> </tr> <tr> <td>ES 475</td> <td>Wind Power Systems</td> <td>3 or 4</td> </tr> <tr> <td>NPRE 199</td> <td>Undergraduate Open Seminar (May be repeated in separate terms to a maximum of 2 times.)</td> <td>1</td> </tr> <tr> <td>NPRE 201</td> <td>Energy Systems</td> <td>2 or 3</td> </tr> <tr> <td>NPRE 398</td> <td>Special Topics</td> <td>1 to 4</td> </tr> <tr> <td>NPRE 481</td> <td>Writing on Technol &amp; Security</td> <td>3 or 4</td> </tr> <tr> <td>NPRE 483</td> <td>Seminar on Security</td> <td>1</td> </tr> </tbody> </table> <p>Thermal Sciences</p> <table border="1"> <thead> <tr> <th>Code</th> <th>Title</th> <th>Hours</th> </tr> </thead> <tbody> <tr> <td>ME 320</td> <td>Heat Transfer</td> <td>4</td> </tr> <tr> <td>ME 400</td> <td>Energy Conversion Systems</td> <td>3 or 4</td> </tr> <tr> <td>ME 402</td> <td>Design of Thermal Systems</td> <td>3 or 4</td> </tr> <tr> <td>ME 404</td> <td>Intermediate Thermodynamics</td> <td>4</td> </tr> <tr> <td>ME 410</td> <td>Intermediate Gas Dynamics</td> <td>3 or 4</td> </tr> <tr> <td>ME 411</td> <td>Viscous Flow &amp; Heat Transfer</td> <td>4</td> </tr> <tr> <td>ME 420</td> <td>Intermediate Heat Transfer</td> <td>4</td> </tr> </tbody> </table> <p>Power and Control Systems</p> <table border="1"> <thead> <tr> <th>Code</th> <th>Title</th> <th>Hours</th> </tr> </thead> <tbody> <tr> <td>ECE 329</td> <td>Fields and Waves I</td> <td>3</td> </tr> <tr> <td>ECE 310</td> <td>Digital Signal Processing</td> <td>3</td> </tr> <tr> <td>ECE 330</td> <td>Power Ckts &amp; Electromechanics</td> <td>3</td> </tr> <tr> <td>ECE 476</td> <td>Power System Analysis</td> <td>3</td> </tr> <tr> <td>ECE 486</td> <td>Control Systems</td> <td>4</td> </tr> </tbody> </table> <p>Solid, Fluid and Continuum Mechanics</p> <table border="1"> <thead> <tr> <th>Code</th> <th>Title</th> <th>Hours</th> </tr> </thead> <tbody> <tr> <td>TAM 251</td> <td>Introductory Solid Mechanics</td> <td>3</td> </tr> <tr> <td>TAM 252</td> <td>Solid Mechanics Design</td> <td>1</td> </tr> <tr> <td>TAM 424</td> <td>Mechanics of Structural Metals</td> <td>3 or 4</td> </tr> <tr> <td>TAM 435</td> <td>Intermediate Fluid Mechanics</td> <td>4</td> </tr> </tbody> </table>			Code	Title	Hours	NPRE 412	Nuclear Power Econ & Fuel Mgmt	3 or 4	NPRE 413	Nuclear Separations and Fuel Reprocessing	2 or 3	NPRE 430	Advanced Materials in Nuclear Engineering	3	NPRE 442	Radioactive Waste Management	3	NPRE 457	Safety Anlys Nucl Reactor Syst	3 or 4	NPRE 461	Probabilistic Risk Assessment	3 or 4	NPRE 480	Energy and Security	0 to 4	NPRE 498	Special Topics	1 to 4	Code	Title	Hours	ES 470	Fuel Cells & Hydrogen Sources	3	ES 475	Wind Power Systems	3 or 4	NPRE 199	Undergraduate Open Seminar (May be repeated in separate terms to a maximum of 2 times.)	1	NPRE 201	Energy Systems	2 or 3	NPRE 398	Special Topics	1 to 4	NPRE 481	Writing on Technol & Security	3 or 4	NPRE 483	Seminar on Security	1	Code	Title	Hours	ME 320	Heat Transfer	4	ME 400	Energy Conversion Systems	3 or 4	ME 402	Design of Thermal Systems	3 or 4	ME 404	Intermediate Thermodynamics	4	ME 410	Intermediate Gas Dynamics	3 or 4	ME 411	Viscous Flow & Heat Transfer	4	ME 420	Intermediate Heat Transfer	4	Code	Title	Hours	ECE 329	Fields and Waves I	3	ECE 310	Digital Signal Processing	3	ECE 330	Power Ckts & Electromechanics	3	ECE 476	Power System Analysis	3	ECE 486	Control Systems	4	Code	Title	Hours	TAM 251	Introductory Solid Mechanics	3	TAM 252	Solid Mechanics Design	1	TAM 424	Mechanics of Structural Metals	3 or 4	TAM 435	Intermediate Fluid Mechanics	4
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CHEM 102	General Chemistry I	3																																																																																																															
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MATH 221	Calculus I (MATH 220 may be substituted. MATH 220 is appropriate for students with no background in calculus. 4 of 5 credit hours count towards degree.)	4																																																																																																															
MATH 231	Calculus II	3																																																																																																															
MATH 241	Calculus III	4																																																																																																															
MATH 257	Linear Algebra with Computational Applications	3																																																																																																															
MATH 285	Intro Differential Equations	3																																																																																																															
PHYS 211	University Physics: Mechanics	4																																																																																																															
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CS 101	Intro Computing: Engrg & Sci (CS 124 may be taken instead of CS 101.)	3																																																																																																															
ECE 205	Electrical and Electronic Circuits	3																																																																																																															
ME 200	Thermodynamics	3																																																																																																															
ME 310	Fundamentals of Fluid Dynamics	4																																																																																																															
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NPRE 200	Mathematics for Nuclear, Plasma, and Radiological Engineering	2																																																																																																															
NPRE 247	Modeling Nuclear Energy System	3																																																																																																															
NPRE 321	Introduction to Plasmas and Applications	3																																																																																																															
NPRE 330	Materials in Nuclear Engineering	3																																																																																																															
NPRE 349	Introduction to NPRE Heat Transfer	2																																																																																																															
NPRE 441	Radiation Protection	4																																																																																																															
NPRE 445	Interaction of Radiation with Matter	4																																																																																																															
NPRE 449	Nuclear Systems Engineering and Design	3																																																																																																															
NPRE 451	NPRE Laboratory	3																																																																																																															
NPRE 455	Neutron Diffusion & Transport	4																																																																																																															
NPRE 458	Design in NPRE	4																																																																																																															
TAM 210	Introduction to Statics (TAM 211 may be taken instead of TAM 210. The extra hour may be applied towards the Professional Concentration Area electives.)	2																																																																																																															
TAM 212	Introductory Dynamics (PHYS 325 may be taken instead of TAM 212 for students pursuing the PHYS minor.)	3																																																																																																															
<b>Total Hours</b>		<b>53</b>																																																																																																															
<b>Professional Concentration Area</b>																																																																																																																	

TAM 445	Continuum Mechanics	4
TAM 451	Intermediate Solid Mechanics	4
TAM 456	Experimental Stress Analysis	3
Computational Sciences and Engineering		
CS 357	Numerical Methods I	3
CS 450	Numerical Analysis	3 or 4
ME 471	Finite Element Analysis	3 or 4
STAT 400	Statistics and Probability I	4
Environmental Engineering and Science		
CEE 201	Systems Engrg & Economics	3
CEE 330	Environmental Engineering	3
CEE 437	Water Quality Engineering	3
CEE 443	Env Eng Principles, Chemical	4
CEE 444	Env Eng Principles, Biological	4
CEE 447	Atmospheric Chemistry	4
<b>Total Hours</b>		<b>17</b>

### Free Electives

Code	Title	Hours
	Additional course work, subject to the Grainger College of Engineering restrictions to Free Electives, so that there are at least 128 credit hours earned toward the degree. ( <a href="https://go.grainger.illinois.edu/FreeElectives/">https://go.grainger.illinois.edu/FreeElectives/</a> )	11
<b>Total Hours of Curriculum to Graduate</b>		<b>128</b>

for the degree of Bachelor of Science in Nuclear, Plasma, & Radiological Engineering with a concentration in Power, Safety & Environment

### Sample Sequence

This sample sequence is intended to be used only as a guide for degree completion. All students should work individually with their academic advisors to decide the actual course selection and sequence that works best for them based on their academic preparation and goals. Enrichment programming such as study abroad, minors, internships, and so on may impact the structure of this four-year plan. Course availability is not guaranteed during the semester indicated in the sample sequence. The curriculum sequence can also be viewed via dynamic and static curricular maps (<https://grainger.illinois.edu/academics/undergraduate/majors-and-minors/npre-power-map/>), which include prerequisite sequencing.

Students must fulfill their Language Other Than English requirement by successfully completing a third level of a language other than English. See the corresponding section on the Degree and General Education Requirements (<http://catalog.illinois.edu/general-information/degree-general-education-requirements/>). One of the SBS courses must be an introductory economics course (ECON 102 or ECON 103). NPRE 481 will satisfy a technical elective requirement in the Professional Concentration Area and the Campus General Education Advanced Composition requirement. If NPRE 481 is not selected, a separate Advanced Composition course must be taken.

Free Electives: Additional course work, subject to the Grainger College of Engineering restrictions to Free Electives (<https://go.grainger.illinois.edu/FreeElectives/>), so that there are at least 128 credit hours earned toward the degree.

First Year		Hours
<b>First Semester</b>		
NPRE 100		1
MATH 221 (MATH 220 may be substituted)		4
ENG 100		1
CHEM 102		3
CHEM 103		1
Composition I or Language Other Than English (3rd level)		4
General Education course (Choose a Humanities or Social/Behavioral Science course with Cultural Studies designation)		3
		<b>17</b>

### Total Hours 17

First Year		Hours
<b>Second Semester</b>		
CS 101 (CS 124 may be substituted)		3
MATH 231		3
PHYS 211		4
Language Other Than English (3rd level) or Composition I		4
ECON 102 or 103		3
		<b>17</b>

### Total Hours 17

Second Year		Hours
<b>First Semester</b>		
NPRE 200		2
MATH 241		4
PHYS 212		4
TAM 210 (TAM 211 may be substituted)		2
General Education course (Choose a Humanities or Social/Behavioral Science course with Cultural Studies designation)		3
Free Elective course		2
		<b>17</b>

### Total Hours 17

Second Year		Hours
<b>Second Semester</b>		
NPRE 247		3
MATH 285		3
ME 200		3
TAM 212 (PHYS 325 may be substituted)		3
Free Elective course		3
		<b>15</b>

### Total Hours 15

<b>Third Year</b>	
<b>First Semester</b>	<b>Hours</b>
NPRE 330 or 321	3
MATH 257	3
NPRE 445	4
TAM 335 (ME 310 may be substituted)	4
General Education course (Choose a Humanities or Social/Behavioral Science course with Cultural Studies designation)	3
	<b>17</b>

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**Total Hours 17**

<b>Third Year</b>	
<b>Second Semester</b>	<b>Hours</b>
NPRE 349	2
NPRE 451	3
NPRE 455	4
ECE 205	3
Technical Elective course	3
	<b>15</b>

**Total Hours 15**

<b>Fourth Year</b>	
<b>First Semester</b>	<b>Hours</b>
NPRE 321 or 330	3
NPRE 432	2
Technical Elective course	3
NPRE 449	3
Technical Elective course	3
Free Elective course	2
	<b>16</b>

**Total Hours 16**

<b>Fourth Year</b>	
<b>Second Semester</b>	<b>Hours</b>
NPRE 441	4
NPRE 458	4
Technical Elective course	3
Technical Elective course	3
	<b>14</b>

**Total Hours 14****Total Hours: 128**

*for the degree of Bachelor of Science in Nuclear, Plasma, & Radiological Engineering with a concentration in Power, Safety & Environment*

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